Recent Status of Polarized Parton Distributions

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We have investigated longitudinal polarized parton distribution functions (pol-PDFs) with experimental data sets from polarized deep inelastic scattering [1]. Furthermore, PDF uncertainty estimation method has been developed in pQCD global analysis. PDF uncertainties can help us to understand optimized PDF in detail, and provides more precise information for predicted physical quantities which are calculated by using the PDFs.

I update AAC analysis including E155 proton data which are precise measurements. The pol-PDFs are provided four type distributions $\Delta u_v(x), \Delta d_v(x), \Delta\bar{q}(x),$ and $\Delta g(x)$ at $Q^2 = 1\ \mathrm{GeV}^2$. These distributions are determined by χ^2 analysis with the spin asymmetry from proton, deuteron and ^{3}He target,

$$A_1(x,Q^2) \cong g_1(x,Q^2)\frac{2x[1+R(x,Q^2)]}{F_2(x,Q^2)}, \tag{1}$$

where $F_2(x,Q^2)$ is unpolarized structure function and $g_1(x,Q^2)$ is polarized one. χ^2 is obtained by $\chi^2 = \Sigma(A_1^{data} - A_1^{calc})^2/(\sigma_{data})^2$ and minimized by using the CERN subroutine MINUIT. In addition to parameterization, the pol-PDF uncertainties can be estimated by Hessian method:

$$[\delta\Delta f(x)]^2 = \Delta\chi^2 \sum_{i,j} \frac{\partial\Delta f(x)}{\partial a_i} H_{ij}^{-1} \frac{\partial\Delta f(x)}{\partial a_j}, \tag{2}$$

where H_{ij} is Hessian matrix which is calculated in minimized process, and $a_{i,j}$ are optimized parameters in the $\chi^2(a_i)$ function. $\Delta\chi^2$ is constant value so as to estimate 1σ standard error in multi-parameter space.

We obtained spin content $\Delta\Sigma = 0.210 \pm 0.148$. Valence quarks had small uncertainties, however antiquark and gluon uncertainty became very large. First moment of valence quarks Δu_v and Δd_v were fixed by hyperon decay constants and assuming antiquark flavor SU(3) symmetry at initial Q_0^2. Spin content is given by $\Delta\Sigma = \Delta u_v + \Delta d_v + 6\Delta\bar{q}$, and so antiquark $\Delta\bar{q}$ seriously affected the spin content and this error. However, $\Delta\bar{q}(x)$ uncertainty indicated that $\Delta\bar{q}(x)$ was not clearly determined by existing polarize DIS data. Furthermore, polarized gluon distribution $\Delta g(x)$ strongly correlated with $\Delta\bar{q}(x)$. This large uncertainty affected spin content error through $\Delta\bar{q}(x)$ uncertainty.

Reference:

[1] Asymmetry Analysis Collaboration (AAC), Y. Goto et. al., Phys. Rev. **D62**, 034017 (2000).
http://spin.riken.bnl.gov/aac/